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(54) Title: TRIM PANEL WITH INTEGRALLY FORMED ELECTRICAL CIRCUITS (57) Abstract <p>A vehicle trim panel of electrically non-conductive material is mounted to the interior of a vehicle door assembly. An exterior surface of the panel includes a decorative trim and an interior surface includes a first electrical connector and a second electrical connector. An electrical circuit is integrally deposited and adhered to the interior surface of the trim panel for electrically connecting the first electrical connector to the second electrical connector. The electrical circuit includes a number of spaced apart circuit traces which feed an electrical current to a number of electrical components. The circuit traces are preferably provided by depositing an electrically conductive fluent material onto the interior surface of the trim panel to define the electrical circuit traces between the first and second electrical connectors. Preferably, the circuit traces are deposited by <u>thermal spraying</u>.</p>		

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TRIM PANEL WITH INTEGRALLY FORMED ELECTRICAL CIRCUITS

BACKGROUND OF THE INVENTION

The subject invention relates to a vehicle trim panel assembly having an
5 integrally molded electrical circuit. The subject invention also relates to the method of
fabricating the trim panel with the electrical circuit.

Vehicles typically have a number of trim panels mounted to different interior
surfaces to present a pleasing appearance. One common type of trim panel is a door trim
10 panel mounted to the interior surface of a door assembly. Typically, vehicle door assemblies
include spaced apart inner and outer panels defining a cavity for mounting a window, window
regulator, speakers and other electrical devices therein. These devices are installed inside the
door cavity through a plurality of access openings provided in the door inner panel.

15 The door trim panel conceals this interior surface of the door. The door trim
panel is conventionally formed of a rigid panel, such as molded plastic or pressed hardboard,
covered with a flexible decorative trim material such as cloth, vinyl, leather and/or carpeting.
The door trim panel is attached to the door by suitable fasteners which creates a pleasing
appearance to the occupant.

20

The door trim panel also often supports a number of electrical components.
These components include, lights, window controls, rear view mirror controls, seat adjustment
controls, and speakers. Each of these electrical components requires an individual wiring

connector and power supply lead wires. The power supply lead wires for all the electrical components are typically bundled together to create what is commonly called a wire harness. The wire harness must be affixed to the trim panel or to the door to eliminate movement of the wires during operating conditions. As can be appreciated, the mounting and wiring of these electrical components is labor intensive and requires a number of connectors and other electrical parts.

Solutions to this problem have been contemplated by the prior art. Specifically, the power supply lead wires are mounted, molded, etched, printed, or otherwise affixed to a separate rigid board material. The rigid board is in turn mounted in some fashion to either the trim panel or the door or both. Hence, in these proposals, the door assembly includes the door itself, a rigid board, and then the trim panel. These proposals, however, likewise have a number of deficiencies. One deficiency is the same as with the loose bundle of wires. This solution still requires a significant amount of intensive manual labor to mount the wires to the board, mount the connectors to the board, and then mount the board itself to either the trim panel or the door. Further, additional connectors must be mounted on the board to electrically connect the connectors from the door to the connectors on the trim panel.

SUMMARY OF THE INVENTION AND ADVANTAGES

In one embodiment, the subject invention includes a trim panel of electrically non-conductive material having an exterior surface and an interior surface. The exterior surface provides a decorative trim and the interior surface includes electrical connectors. An electrical circuit is integrally deposited and adhered to the interior surface of the trim panel

for electrically connecting the electrical connectors and/or components.

The subject invention also includes a method of fabricating a vehicle trim panel with an integral electrical circuit. In a preferred method, a template with openings is placed
5 over the interior surface of the trim panel prior to deposition of the material. The method includes depositing an electrically conductive fluent material directly onto the interior surface of the trim panel to define the electrical circuits. Preferably the fluent material is a liquid. Also it is preferred the electrically conductive liquid material is allowed to cure, such that it adheres and hardens on the trim panel prior to removing the template from the interior surface
10 of the trim panel.

The invention thus provides a vehicle trim panel having an integrally molded electrical circuit for interconnecting any number of electrical devices. The trim panel of the subject invention can be efficiently manufactured and may not require any additional
15 components or connectors. In other words, all of the parts necessary to electrically connect an electrically operated component to an electrical supply are included within the trim panel itself. These parts include the connectors and the electrical circuit which are all preferably integrally molded into the trim panel. Some of the components, however, may need to be separately affixed to the trim panel.

20

BRIEF DESCRIPTION OF THE DRAWINGS

Other advantages of the present invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when

considered in connection with the accompanying drawings wherein:

Figure 1 is a perspective view of a trim panel assembly in spaced relationship to a vehicle door assembly;

Figure 2 is a cross-sectional view taken along line 2-2 of Figure 1;

5 Figure 3 is a partially cross-sectional view of an electrical component; and

Figure 4 is a partially broken perspective view of the trim panel during the method of fabrication.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

10 A vehicle trim panel assembly is generally shown at 10 in Figure 1. The trim panel assembly 10 comprises a trim panel 12 of electrically non-conductive material having an exterior surface 14 and an interior surface 16. The trim panel 12 of the preferred embodiment is a automotive door trim panel 12 which mounts to a vehicle door assembly, generally shown at 18. As appreciated by those skilled in the art the trim panel 12 of the
15 subject invention may be any type of trim panel associated with a vehicle without deviating from the scope of the subject invention. Other types of trim panels include trunk panels, quarter panels, rear package trays, headliners, instrument panels, garnish moldings, and console panels.

20 The vehicle door assembly 18 includes spaced apart inner 20 and outer 22 metal panels defining a cavity (not numbered) for mounting a window, window regulator, speakers, and other electrical devices (not shown). A plurality of access openings 24 are provided in the inner panel 20 to allow access into the cavity of the door assembly 18. Door

trim panel 12 is utilized to conceal this interior surface 20 of the vehicle door 18.

The door trim panel 12 is preferably formed of a molded plastic such as polypropylene. As appreciated by those skilled in the art, the trim panel 12 may be fabricated
5 of wood fibers, polyurethane, solid molded vinyl, expanded polyurethane foam, any combination thereof or any other suitable rigid electrically non-conductive material. The exterior surface 14 of the trim panel 12 includes a decorative surface. Specifically, the trim panel 12 may be covered with a flexible decorative trim material 26 such as cloth, vinyl, leather, and/or carpeting. The trim panel 12 is attached to the vehicle door 18 by suitable
10 fasteners (not shown) as are well known in the art.

The interior surface 16 of the trim panel 12 includes a first electrical connector 28 and a second electrical connector 30. As shown in the preferred embodiment there are a number of second electrical connectors 30. These electrical connectors 28, 30 can be of any
15 suitable design or configuration without deviating from the scope of this invention. One contemplated design for a second electrical connector 30 is shown in Figure 3 and discussed in greater detail below. The interior surface 16 of the trim panel 12 also supports a number of electrical components. These components can include, window controls, rear view mirror controls 36, seat adjustment controls, and speakers 38. Each of these electrical components
20 36, 38 typically have an associated individual second electrical connector 30.

An electrical circuit, generally shown at 40, is integrally deposited and adhered
to the interior surface 16 of the trim panel 12 for electrically connecting the first electrical

connector 28 to the at least one of second electrical connectors 30. The method of depositing the electrical circuit 40 is discussed in greater detail below. The electrical circuit 40 formed within the trim panel 12 comprises a plurality of spaced apart circuit traces 42 or strips of conductive material. For illustrative purposes, seven traces are shown in Figure 1, however, 5 any number of traces 42 may be utilized as deemed necessary. As appreciated by those skilled in the art, most electrical components require at least two input supply wires, i.e., a ground wire and an input wire carrying an electrical current. Further, if the electrical component is a switch, there will be at least one output wire also carrying an electrical current. Hence, the number of traces 42 formed in the electrical circuit 40 will depend on the 10 number and type of electrical components used. Each individual trace 42 can vary in width and thickness to accommodate varied gauges and to customize resistivity.

As discussed above, the trim panel 12 is mounted to the inner panel 20 of the vehicle door assembly 18. To prevent a short circuit the electrical circuit 40 of the trim panel 12 is preferably spaced some distance from the door assembly 18. Further, an insulative coating (not shown) or similar material may be applied over the electrical circuit 40 to create a protective moisture barrier between the door assembly 18 and the trim panel 12. 15

The vehicle door assembly 18 also includes at least one corresponding electrical 20 connector 44. A vehicle wire harness 46 is coupled to the electrical connector 44 of the door assembly 18. Hence, the electrical connector 44 of the door assembly 18 is the main power supply source for all the components within the vehicle door 18 and the trim panel 12. At least one of the first 28 and second 30 electrical connectors of the trim panel 12 is electrically

connected to the electrical connector 44 of the door assembly 18. Specifically, the first electrical connector 28 of the trim panel 12 is electrically connected to the electrical connector 44 of the door assembly 18 and the second electrical connector 30 of the trim panel 12 is electrically connected to one of the electrically operated components 36, 38. Accordingly, every circuit trace 42 of the electrical circuit 40 begins at the first electrical connector 28 and travels along the trim panel 12 to the designated electrical component 36, 38. Hence, the electrical current travels from the vehicle wire harness 46, through the electrical connector 44 of the door assembly 18, through the first electrical connector 28 of the trim panel 12, through the electrical circuit 40, through the second electrical connector 30 of the trim panel 12, and finally into the designated electrical component 36, 38.

A portion of the electrical circuit 40 is shown in greater detail in Figure 2. The electrical circuit 40 is adhered to the interior surface 16 of the trim panel 12. The electrical circuit 40 may also form a relatively small groove (not shown) within the trim panel 12. As shown in the preferred embodiment, the electrical circuit 40 is disposed along a thickened portion 50 molded within the interior surface 16 of the trim panel 12. Hence, the exterior surface 14 of the trim panel 12 is not effected by the deposition of the electrical circuit 40 on the interior surface 16. For illustrative purposes five spaced apart circuit traces 42 or strips are shown, however, as discussed above, the number of traces 42 will depend upon the number and type of electrical components.

Turning to Figure 3, one of the second electrical connectors 30 is shown in greater detail. Specifically, a cavity 52 is formed within the exterior surface 14 of the trim

panel 12 and extends into the interior surface 16. The electrical circuit 40 is deposited on at least a portion of the cavity 52. A metal strip 54 is deposited on at least a portion of one of the electrically operated components. The electrically operated component shown in Figure 3 is the rear view mirror control 36. The mirror control 36 is mounted within the cavity 52 to electrically connect the mirror control 36 to the electrical circuit 40 within the cavity 52. As discussed above, the electrical circuit 40 is connected to the electrical connector 44 in the vehicle door 18, i.e., the main power supply. Hence, the rear view mirror control 36 is now connected to the main power supply. The mirror control 36 is simply an illustration of one type of electrical component and the scope of the subject invention is in no way limited to this type of device.

Referring now to Figure 4, the method of fabricating the trim panel 12 with the electrical circuit 40 is disclosed in greater detail. Briefly, a template 56 having openings 58 is applied to the interior surface 16 of the trim panel 12. The electrical circuit 40 is then deposited on the trim panel 12 by spraying molten metal particles through the openings 58 and onto the interior surface 16 of the trim panel 12. For illustrative purposes, only a portion of the trim panel 12 and template 56 are shown.

More specifically, the method of fabricating the vehicle trim panel 12 with the electrical circuit 40 comprises the steps of providing the trim panel 12 having the interior surface 16, the exterior surface 14 with the decorative appearance, and spaced first 28 and second 30 electrical connectors. An electrically conductive fluent material is then deposited onto the interior surface 16 of the trim panel 12 to define the electrical circuit 40 between the

first 28 and second 30 electrical connectors. Preferably the fluent material is a liquid. The electrically conductive liquid material is then cured to adhere and harden to the trim panel 12, whereby the electrical circuit 40 is electrically conductive between the first 28 and second 30 connectors. The curing of the liquid material is defined as allowing the liquid or otherwise
5 fluent material to harden into a solid state.

The method of fabricating the trim panel 12 is further defined by applying the template 56 with the openings 58 on the interior surface 16 of the trim panel 12. The electrically conductive liquid material is then deposited through the openings 58 and onto the
10 interior surface 16 of the trim panel 12. The template 56 may then be removed from the interior surface 16 of the trim panel 12, whereby the electrical circuit 40 is electrically conductive between the first 28 and second 30 connectors. As discussed above, the electrical circuit 40 comprises a plurality of spaced apart traces 42. As can be appreciated, the location of the spaced apart traces 42 on the trim panel 12 corresponds to the position of the openings
15 58 in the template 56. Again for illustrative purposes, only a pair of openings 58 in the template 56 are shown in Figure 4.

The method of depositing the electrically conductive liquid material is preferably defined by spraying molten metal particles through the openings 58 and onto the
20 interior surface 16 of the trim panel 12. The molten metal particles of the preferred embodiment preferably are pure copper which has a melting point of approximately 400°F. As appreciated by those skilled in the art, other types of metal, such as zinc, may be utilized so long as the metal has sufficient conductivity characteristics and will adhere to the trim

panel 12.

The spraying of the molten metal particles is further defined by feeding metal wire into a gas flame and driving the molten metal particles against the interior surface 16 of the trim panel 12. This method of application is commonly called thermal spraying. The driving of the molten metal particles during the thermal spraying process could occur by other methods, such as utilizing a high velocity gas, a wire arc spray, a combustion spray, or a plasma inert gas spray. As appreciated by those skilled in the art, the molten metal particles may be deposited onto the trim panel 12 by other means without deviating from the overall scope of the subject invention. Other means can include pouring the molten metal, electrolysis printing, electrostatic painting, plating, extruding the metal, or utilizing a slurry, powder, or paste of molten metal.

The depositing of the electrically conductive liquid material is further defined by molding the thickened portion 50 of the trim panel 12 in close proximity to the openings 58 of the template 56. As discussed above, the thickening of the trim panel 12 ensures that the exterior 14 or decorative surface is not affected by the deposition of the electrical circuit 40 on the interior surface 16 of the trim panel 12.

This overall method of fabricating the door trim panel 12 is further defined by mounting the trim panel 12 to the vehicle door assembly 18. The method of mounting the trim panel 12 to the door assembly 18 is further defined by electrically connecting at least one of the first 28 and second 30 electrical connectors of the trim panel 12 with the electrical

connector 44 of the door assembly 18. Specifically, the method of mounting the trim panel 12 to the door assembly 18 is further defined by electrically connecting the first electrical connector 28 of the trim panel 12 with the electrical connector 44 of the door assembly 18 and electrically connecting the second electrical connector 30 of the trim panel 12 with one
5 of the electrically operated components 36, 38.

The invention has been described in an illustrative manner, and it is to be understood that the terminology which has been used is intended to be in the nature of words of description rather than of limitation. Obviously, many modifications and variations of the
10 present invention are possible in light of the above teachings. It is, therefore, to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

CLAIMS

WHAT IS CLAIMED IS:

1. A method of fabricating a vehicle trim panel with an electrical circuit comprising the steps of:
 - 5 1) providing a trim panel having an interior surface, an exterior surface with a decorative appearance, and spaced first and second electrical connectors;
 - 2) depositing an electrically conductive fluent material onto the interior surface of the trim panel to define the electrical circuit between the first and second electrical connectors; and
 - 10 3) curing the electrically conductive fluent material to adhere and harden to the trim panel, whereby the electrical circuit is electrically conductive between the first and second connectors.
2. A method as set forth in claim 1 wherein the method of mounting the trim
15 panel to the door assembly is further defined by electrically connecting at least one of the first and second electrical connectors of the trim panel with an electrical connector of the door assembly.
3. A method as set forth in claim 1, wherein a template is placed on said
20 interior surface, said template provided with openings and the depositing of step 2) including said fluent material passing through said openings and onto said inner surface.

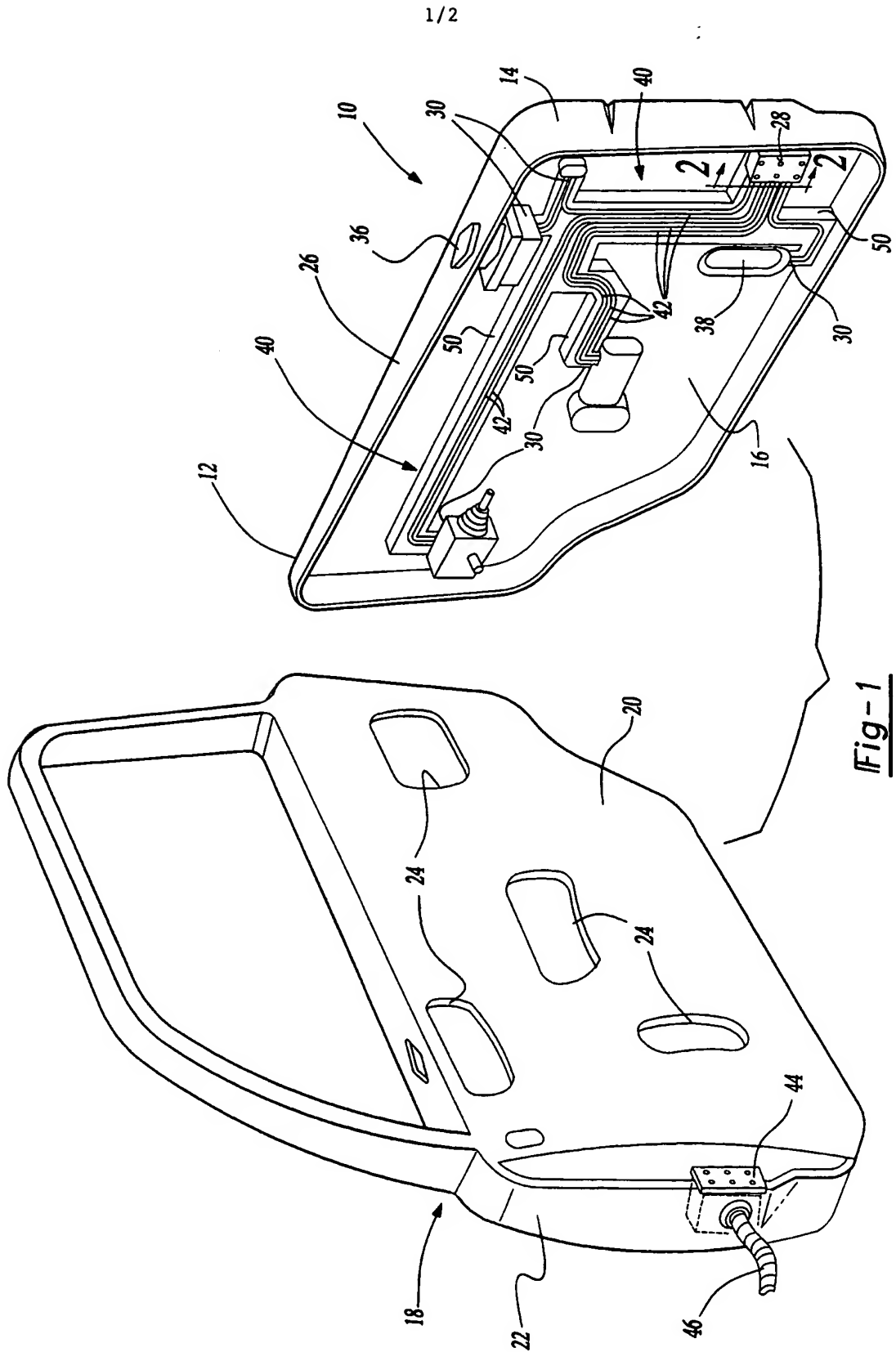
4 A method as set forth in claim 3 wherein the method of depositing the electrically conductive fluent material is further defined by spraying molten metal particles through the openings and onto the interior surface of the trim panel.

5 5. A method as set forth in claim 4 wherein the spraying of the molten metal particles is further defined by feeding metal wire into a gas flame and driving the molten metal particles against the interior surface of the trim panel.

6. A method as set forth in claim 3 wherein the provision of the trim panel
10 in step 2) is further defined by molding a thickened portion of the trim panel in proximity to the openings of the template.

7. A vehicle trim panel assembly comprising,
a trim panel of electrically non-conductive material having an exterior surface
15 and an interior surface,
said exterior surface including a decorative trim mounted thereon,
said interior surface including a first electrical connector and a second electrical
connector, and
an electrical circuit integrally deposited and adhered to said interior surface of
20 said trim panel for electrically connecting said first electrical connector to said second
electrical connector.

8. An assembly as set forth in claim 7 wherein said electrical circuit comprises a plurality of spaced apart circuit traces integrally formed within said trim panel.
9. An assembly as set forth in claim 7 including a cavity formed within said exterior surface of said trim panel and extending into said interior surface with said electrical circuit deposited on at least a portion of said cavity.
10. An assembly as set forth in claim 9 wherein said electrical circuit is deposited on at least a portion of an electrically operated component to electrically connect said electrically operated component to said electrical circuit within said cavity.
11. An assembly as set forth in claim 7 wherein said electrical circuit is disposed along a thickened portion molded within said interior surface of said trim panel.



SUBSTITUTE SHEET (RULE 26)

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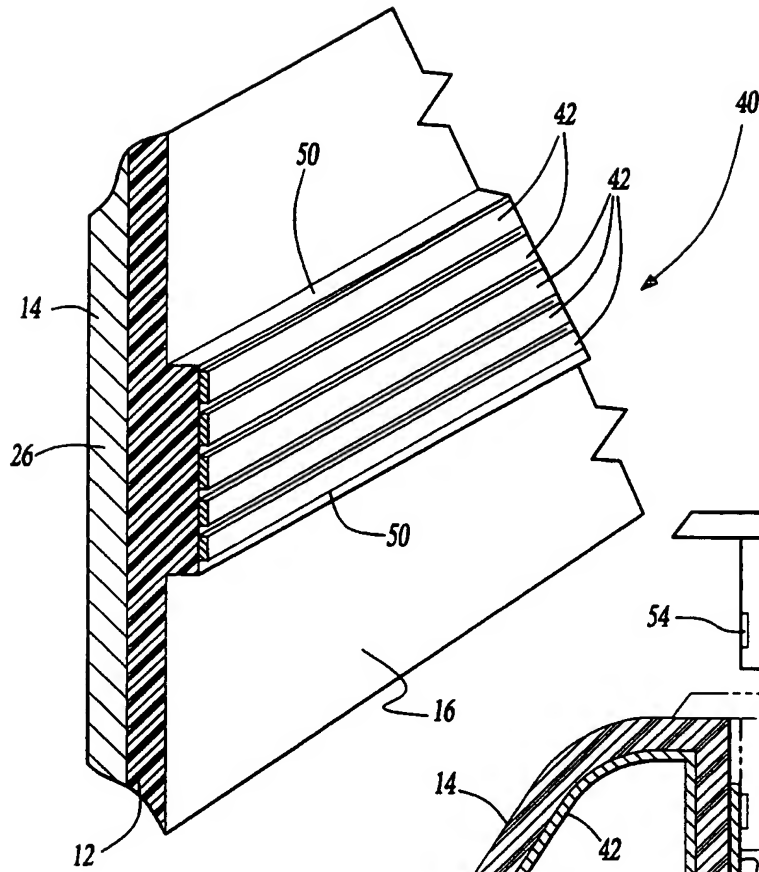


Fig-2

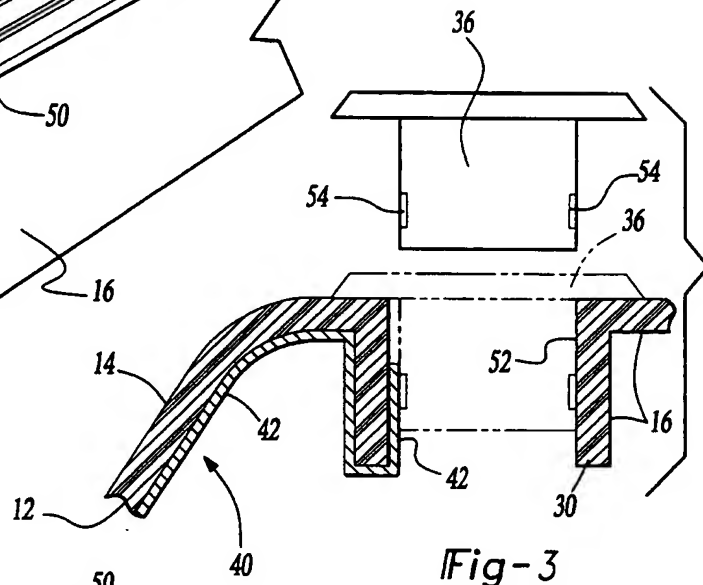


Fig-3

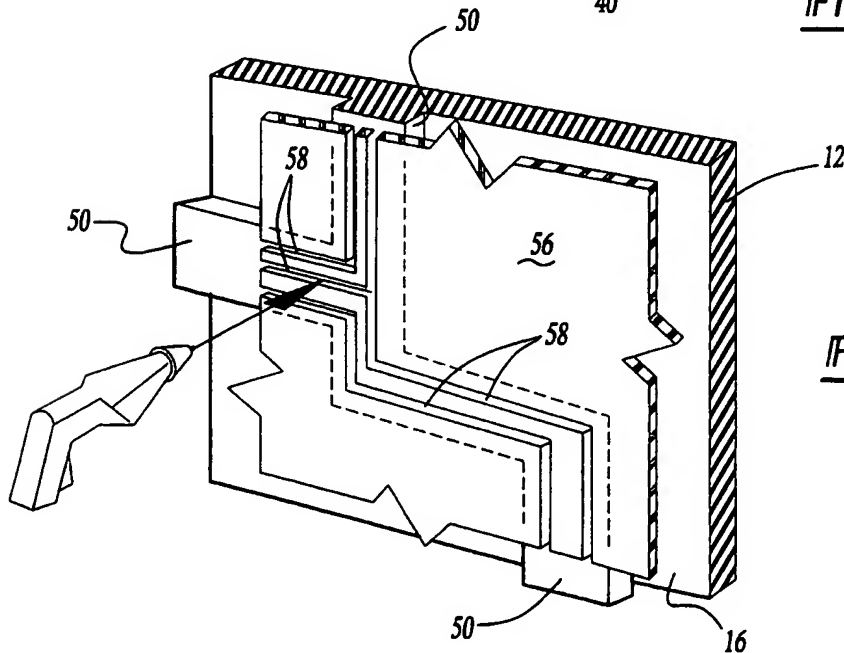


Fig-4

SUBSTITUTE SHEET (RULE 26)

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 99/06244

A. CLASSIFICATION OF SUBJECT MATTER IPC 6 B60R16/02		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) IPC 6 B60R H05K		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practical, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	the whole document	7-11
Y	DE 30 23 905 A (OPEL ADAM AG) 14 January 1982 (1982-01-14) page 5, line 30 - page 6, line 9 page 10, line 1 - line 32; figures 1-4	1-4
X	DE 37 40 593 A (YAZAKI CORP) 8 June 1989 (1989-06-08) the whole document	7-11
Y	DE 38 42 340 A (OPEL ADAM AG) 21 June 1990 (1990-06-21)	1-4
X	the whole document	7-11
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Date of the actual completion of the international search 23 July 1999		Date of mailing of the international search report 30/07/1999
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	<p>WO 96 22672 A (PARKER HANNIFIN CORP)</p> <p>25 July 1996 (1996-07-25)</p> <p>page 5, line 6 - page 6, line 17; claims</p> <p>1,11,27; figures 3-6</p> <p>-----</p>	1-4

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INTERNATIONAL SEARCH REPORT

Information on patent family members

In International Application No

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